IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 11, November 2016

Comparative Analysis of Digital Image Watermarking based on discrete cosine transform and Discrete Wavelet Transform Domain

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Abstract: Due to rapid growth in use of networked multimedia system has created need for copyright protection of digital media like image, video, audio. The watermarking techniques used to solve the problem of protecting digital media. Till date various schemes of digital watermarking have been proposed. This paper present comparative analysis of watermark embedded in the host image by discrete cosine transform (DCT) and by discrete wavelet transforms (DWT) using MATLAB. Experimental results confirm that the watermarking in DWT domain provides good image quality than the DCT domain.

Keywords: Digital watermarking, DCT, DWT, MATLAB.

I. INTRODUCTION

There has been rapid growth of internet and communication techniques in recent years, due to which the security and the secrecy of the critical data is of great importance. To protect this data from tampering and unauthorized access, there are various methods for data hiding like cryptography, steganography, watermarking has been used. The prime advantage of watermarking is that the secret information permanently embedding in multimedia content. Several data hiding systems use human perceptual weaknesses to their advantage, but have weaknesses of their own [1].

Digital watermarking is a process of embedding authentic information in multimedia contents to establish their identification and authentication. This technology embeds a data with visible or invisible digital code called watermark which carries information about copyright protection. The watermark can be logo, string, image, audio or any video.

II. WATERMARKING PROCESS

Figure 1 shows the process of watermarking.

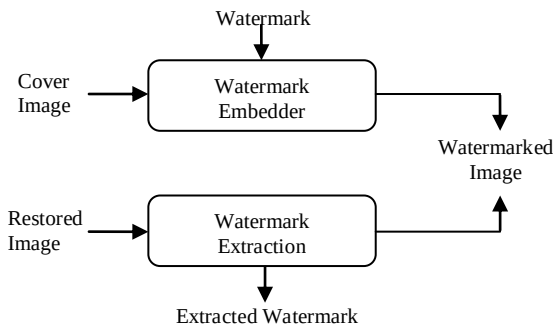

Fig. 1 Watermarking Process

Generally watermarking process involves two steps watermark embedding and watermark extraction. To get watermarked image as output, the input should be original image and secret information (watermark) .The secret information is added over the original image to form watermarked image. For extraction process is opposite to embedding process, it take watermarked image as input and secret information and restored original image as output. This is complete process of digital watermarking.

By using original watermark and extracted watermark we calculate bit error rate to detect the presence of watermark. If the bit error rate is zero it indicates the presence of watermark; otherwise if it is one, it indicates absence of watermark. Bit error rate (BER) is calculated as follows. Suppose E is the retrieved signal and N is the number of bits in watermark then:

$$E = \begin{cases} 1 \text{ if} W_i \neq W_i' \\ 0 \text{ if} W_i = W_i' \end{cases} \qquad BER(W, W') = \frac{\sum E}{N}$$

Normalized Correlation Coefficient can also be used to detect the presence of watermark

$$NC(W, W') = \frac{\sum WW'}{\sqrt{\sum W_i^2 \sqrt{\sum W_i'^2}}}$$

III. DIGITAL IMAGE WATERMARKING

Image watermarking is a process of inserting watermark into image. Images can be represented in Spatial (pixels) and transform domain (frequency). The Spatial domain methods are based on modification of the values of the image pixels directly, so the watermark has to be embedded in this way. Such methods are simple and more computational efficient, because they enhance the colour, luminance or brightness values of a digital image pixels.

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Therefore it is very easy, and requires minimal computational power for their application.
Frequency Domain watermarking is an alternative to spatial domain watermarking. It has been pointed out that the frequency domain (transform domain) methods are more robust than the pixel domain (spatial domain) techniques because information can be spread out to entire image. A transformation function transforms image from spatial domain to frequency domain. For frequency transform, there are different types like: Discrete Fourier Transform (DFT), Discrete Wavelet Transform (DWT), and Discrete Cosine Transform (DCT). DCT and DWT becomes research focus area.DCT is similar to DFT expect that it use only real value.[2]

Figure 2 shows the process of watermarking embedding process on transform domain (DCT and DWT).

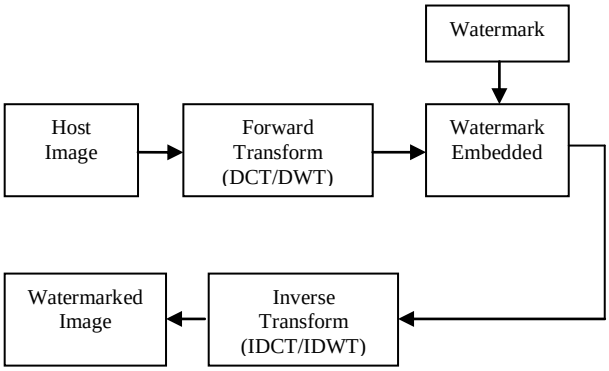

Fig. 2 Watermark embedding process in transform domain

I.J. Cox[3] keeping in mind human persistence of vision first started inserting watermark in the significant perceptual component of HVS. In other words, they modify the insubstantial part, such as LSB in spatial domain and high frequency in frequency domain. They developed the first frequency domain watermarking scheme. In this paper discuss image watermarking embedding algorithm using DCT and DWT domain

IV. DISCRETE COSINE TRANSFORM

The DCT is one of the most popular transform functions in signal processing. DCT separates images into different frequencies parts where less important frequencies are discarded through quantization and important frequencies are used to retrieve the image during decompression. Watermarking in DCT domain is more robust than spatial domain watermarking [3].

Watermarking based on DCT domain can classify into Global DCT watermarking and Block DCT watermarking. In the Global DCT watermarking, the DCT is performed on the whole image, while in the Block-based DCT the image is divided into non-overlapping blocks and DCT is performed on each block separately to obtain low frequency, mid frequency and high frequency sub-bands.

In this paper Block based DCT watermarking is used .Block based DCT divides the image into non-overlapping block. Image is divided into 8 x 8 blocks. Apply forward DCT to each block and find highest coefficient criteria and then insert watermark into selected coefficient. Finally, apply inverse DCT transform on each block to get watermarked image.

V. DISCRETE WAVELET TRANSFORM

In the field of signal processing wavelet transform has been widely used. In some applications wavelet based watermarking schemes outperforms DCT based approaches. The discrete wavelet transform uses different wavelet filters, most commonly used wavelet filters for watermarking are Daubechies Filter and Haar Wavelet Filter. In this paper we use single level 2D DWT using haar wavelet filter. The single level 2D DWT is decomposes image in to four frequency components which contain one low frequency (LL) and three higher frequency component (LH,HL,HH) as shown in fig.3.

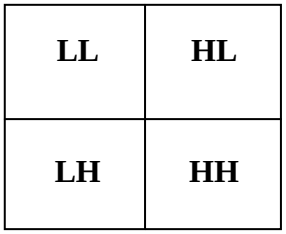

Fig. 3 Single level decomposition using DWT

Watermark embedding process in DWT domain is done by using haar wavelet transform. First apply haar wavelet transform to image and then apply watermark into LL band. Finally get the watermarked image by applying inverse DWT.

VI. EXPERIMENTAL RESULT

The Experiments have been carried out on the 512x512 host images in MATLAB. Here uses the image as a watermark. In this PSNR is calculated for original image and watermarked image in both transform domain (DCT and DWT). The input image is the may be RGB image or Gray scale image .First convert RGB to gray scale because it has reduce the time complexity then apply watermarking on it. The watermarking is done using DCT and DWT domain separately. Fig.4 shows the original images used as input to watermarking Embedding Process. Here use image as a watermark shown in fig.5.
For performance evaluation of watermarking scheme we calculate PSNR. PSNR is peak signal noise ratio which commonly used to measure the quality of output image. PSNR is an approximation to human perception of reconstruction quality. If PSNR is higher, this indicates that higher quality image reconstruction. PSNR is calculated between original image I(i,j) and watermarked image w(i,j).

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(a) (b)

Fig. 4 Host Images on which watermark is inserted (a) wallpaper, (b) car

Fig. 5 Watermark Image

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To compute the PSNR, first calculates the mean-squared error using the following equation:

$$\mathrm{MSE} = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}(I(i,j) - w(i,j))^2$$

In the above equation, m and n are the number of rows and columns in the input images, respectively. Now computes the PSNR using the following equation:

$$\mathrm{PSNR} = 10\ \log_{10}\frac{\mathrm{MAX}_I^2}{\mathrm{MSE}}$$

In the above equation, MAX_I is the maximum fluctuation in the input image data type. For example, MAX_I is 1 when input image is a double-precision floating data type, and MAX_I is 255 when the input image is an 8-bit unsigned integer data type. Table I shows the PSNR for different images in DCT and DWT domain. Form this it confirm that the watermarking in DWT domain have more image quality than watermarking in DCT domain.

TABLE I COMPARISON BETWEEN WATERMARKING BASED ON DCT AND DWT DOMAIN ON DIFFERENT IMAGES USING PSNR.

Images	PSNR for DCT	PSNR for DWT
Wallpaper	40.7711	85.6561
Car	42.7656	86.9931
Leena	41.4156	86.2821

VII. CONCLUSION

In this paper, digital watermarking on image using DCT and DWT domain discussed. The experiment is carried out on host image and watermark image using MATLAB, and calculate the PSNR in DCT and DWT domain separately. The PSNR of watermarking process in DWT is higher than DCT domain. It confirm that the watermarking in DWT domain have more image quality than watermarking in DCT domain.

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